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Agricultural Memorandum No. 264

Mean Excess Winter Rain in England

Once the date of return to capacity has been estimated (Ag. Memo. 250), it is a simple matter to calculate the excess winter rain which falls until the end of March (end of February if March is dry).

Winter averages of potential transpiration at average county heights were used throughout as deviations from such averages are of second order magnitude in this context.

The results for about 80 stations over the years 1940-59 are included in Appendix I, showing

Station and its average annual rainfall (standard period)
Least and most excess winter rains
25% levels (quartile boundaries)
Mean and standard deviation (All figures in inches)

Approximate formulae are as follows, where R = average annual rainfall

(a)	Mean excess winter rain	NORTH	0.8R - 12.4
		MIDLANDS	0.83R - 13.5
		SOUTHWEST	0.82R - 13.6
		SOUTHEAST	0.77R - 12.6
		EAST	0.62R - 8.8
		Whole country	0.81R - 13.1
(b)	Standard deviation		0.17R - 0.85
(c)	Least excess rain		0.5R - 10.9
(d)	25% low		0.68R - 12.1
(e)	25% high		0.9R - 13.0
(f)	Most excess rain		1.12R - 13.3

Such equations offer the opportunity to interpolate estimates of these parameters for anywhere in England, using the standard rainfall averages.

For other purposes, a further refinement would be to use the 20 year mean annual rainfall over the 1940-59 period as the independent variable.

Effect of month when soil returns to capacity

Appendix II shows the results analysed with respect to rainfall range and month of return to capacity. Approximate formulae are:-

Return in August:	Mean excess winter rain	0.615R - 1.8
September		0.53R - 1.0
October		0.27R + 3.4
November		0.55R - 5.45
December		0.21R + 0.5
January		0.25R - 3.35

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There is a distinct anomaly here in the October and November data. Despite a one month longer 'winter' of rainfall after October, means of excess rain are similar to the November figures in the 28-34 rainfall range, and lower than such figures in the higher ranges. This may be a real climatic feature, in that October rains may be associated with cold dry winters; November rains may be associated with wetter winters.

Appendix III shows the analysis with respect to rainfall range and the soil moisture deficit at the end of August.

It had been noted earlier that maximum deficits of 5 in. had been followed by earlier returns to capacity than lower deficits. The mean excess rain figures show high values in the 5 in. (max) column at rainfalls above 26 inches annual average. This is either due to the smallness of the sample or may be a climatic effect in that very dry summers tend to be followed by wet winters. All that can be said here is that such a state of affairs did occur during the 1940-59 period.

Regression formulae are:-

Soil moisture status Aug. 31st	Excess winter rain (in.)
Capacity	0.95R - 13.66
0-1 in.	0.63R - 6.27
1-2 in.	0.50R - 2.22
2-3 in.	0.58R - 6.52
3-4 in.	0.65R - 9.72
4-5 in.	0.58R - 8.54
5in (max)	1.03R - 18.86

where R = average annual rainfall for standard period.

Any comments or criticism on this memorandum should be sent to the Author.

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APPENDIX I

NORTH

	Average Annual Rainfall	Least	25% less than	Mean and Standard Deviation	25% more than	Most
Ambleside	74.4	33.40	43	52.0 (11.5)	60	85.60
Bolton	56.4	14.75	21	25.4 (5.7)	30	35.00
Morecombe	38.4	7.90	16	18.25 (5.5)	21	32.90
Ilkley	37.7	9.70	13	17.35 (5.4)	21	28.90
Newton Rigg	34.9	7.05	14	16.6 (4.8)	20	27.20
Bellingham	34.7	8.50	13	16.1 (4.5)	19	26.60
Blackpool	35.1	5.20	12	15.0 (5.0)	17	26.55
Carlisle	32.1	6.65	11	14.4 (4.6)	18	26.70
Manchester	33.8	7.60	11	14.3 (4.3)	17	24.80
Ampleforth	30.0	4.20 ~~4.85~~	7	11.45 (5.4)	16	22.80
Cockle Park	28.7	4.55	7	10.8 (4.6)	16	18.30
Houghall	27.9	4.15	6	9.35 (4.2)	13	18.75
Mansfield	27.5	2.90	5	8.85 (4.7)	11	19.65
Driffield	26.0	2.70	5	8.7 (4.2)	13	16.30 ~~14.90~~
Wakefield	26.4	2.75 ~~3.0~~	5	8.6 (4.2)	11	19.70
Tynemouth	25.9	3.10	6	8.2 (3.9)	10	17.05
Askham Bryan	26.0	2.05	5	7.7 (3.8)	12	15.25
Hull	25.4	1.75	5	7.7 (4.4)	10	17.45
Berwick	23.3	1.40	5	7.25 (3.0)	9	12.55
Finningley	22.3	0.40	3	5.25 (3.3)	7	12.30

Mean = 0.8R - 12.4 inches

MIDLANDS

	Average Annual Rainfall	Least	25% less than	Mean and Standard Deviation	25% more than	Most
Hanley	33.0	6.90	10	13.3 (4.2)	16	~~20.40~~ 21.10
Delamere	32.9	7.40	10	13.15 (4.3)	17	23.15
Birmingham	30.7	4.55	10	12.35 (4.3)	14	22.50
Belper	28.8	6.75	9	11.45 (3.8)	15	19.95
Gt Missenden	30.5	5.00	8	10.9 (4.2)	12	22.35
Walsall	29.3	5.40	8	~~10.5~~ 10.65 (4.0)	13	21.65
Chip. Norton	29.1	1.95	7	10.0 (4.4)	12	18.70
Ross-on-Wye	27.9	2.95	7	9.75 (4.1)	12	17.50
Leicester	26.4	2.65	7	9.55 (4.1)	12	19.55
Towcester	26.6	1.60	6	9.05 (4.0)	11	16.30
Cheltenham	27.3	0.60	6	8.55 (4.1)	12	16.55
Oxford	25.7	1.10	6	8.0 (3.5)	10	13.80
Worcester	25.3	1.40	7	7.75 (3.4)	10	~~12.30~~ 15.30
Shrewsbury	25.7	2.35	6	~~7.25~~ 7.5 (3.0)	9	14.60
Kettering	24.4	1.20	5	7.15 (3.5)	11	12.20
Leamington Spa	24.6	0.0	5	7.1 (3.7)	9	15.90
Sutton Bonington	23.0	2.10	4	7.0 (3.2)	9	14.15
Ketton	23.7	0.25	4	6.75 (3.8)	10	14.30
Newton Pagnell	24.3	0.30	4	6.45 (3.1)	9	12.05
Cranwell	23.5	1.40	3	5.3 (2.8)	6	11.15

Mean = 0.83R - 13.5 inches

SOUTHWEST

	Average Annual Rainfall	Least	25% less than	Mean and Standard Deviation	25% more than	Most
St. Austell	48.4	16.25	20	26.45 (7.8)	29	40.60
Plymouth	37.8	8.55	13	17.85 (5.4)	22	29.95
Hartland Pt.	36.3	6.60	11	15.15 (5.9)	18	27.50
Lizard	33.0	7.50	10	15.05 (5.7)	21	24.10
Blandford	34.2	6.30	11	14.35 (5.3)	18	26.65
Newquay	34.2	6.60	11	14.65 (5.7)	17	26.85
Marlborough	33.6	5.35	12	13.7 (5.2)	16	23.90
Bristol	32.2	5.15	10	12.7 (4.1)	14	21.80
Leckford	31.6	1.60	9	12.35 (5.3)	15	24.10
Bournemouth	31.1	3.25 ~~4.50~~	8	11.7 (4.8)	14	20.35
Exeter	31.9	5.25	7	11.3 (5.1)	16	23.30 ~~18.75~~
Boscombe Down	28.5	3.40	8	10.7 (4.3)	13	21.95
Cannington	29.9	4.15	7	10.3 (4.2)	13	19.45
Martock	29.0	1.25	8	9.9 (3.6)	13	16.40

Mean = 0.82R - 13.6 inches

SOUTHEAST

	Average Annual Rainfall	Least	25% less than	Mean and Standard Deviation	25% more than	Most
Bodiam	31.7	2.65	9	12.65 (4.8)	17	22.20
Chichester	29.7	4.10	8	11.4 (4.5)	15	21.55
Wye	30.4	1.50	7	10.25 (4.5)	14	18.10
Wantage	28.8	2.20	7	10.1 (4.6)	13	20.75
Portsmouth	27.8	2.70	6	9.35 (4.2)	13	16.85
Rothamsted	28.4	2.35	7	8.45 (3.5)	11	16.30
E. Malling	26.9	2.90 ~~2.55~~	5	8.2 ~~8.0~~ (3.6)	10	15.10
S. Farnborough	26.9	2.10	6	7.8 (3.6)	10	16.40
Wealdstone	27.5	1.35	5	7.45 (3.3)	9	14.80
Croydon	27.3	1.30	5	7.35 (3.8)	10	14.70 ~~14.45~~
Reading	25.7	2.25	4	6.85 (3.4)	9	13.35
Kew	24.0	0.95	3	5.5 (3.1)	7	12.10 ~~11.55~~
Swanley	23.0	0.80	3	5.55 ~~5.15~~ (3.0)	7	11.65
Margate	21.2	0.60	2	4.95 (2.8)	7	9.00

Mean = 0.77R - 12.6 inches

EAST

	Average Annual Rainfall	Least	25% less than	Mean and Standard Deviation	25% more than	Most
Swaffham	25.4	1.00	6	6.7 (3.2)	9	~~12.15~~ 12.65
Sprowston	25.4	0.10	5	6.65 (3.0)	8	12.85
Cleethorpes	23.4	1.80	5	6.5 (3.2)	9	12.70
Spalding	23.6	1.05	5	6.4 (3.3)	9	13.15
Lowestoft	23.6	0.70	4	5.95 (3.4)	8	~~9.30~~ 15.10
Kings Lynn	22.6	0.65	3	5.55 (2.9)	7	11.35
March	23.1	0.55	3	5.5 (2.9)	7	11.00
Saffron Walden	23.3	0.50	4	5.4 (2.7)	7	9.25
Sandy	22.8	0.0	3	5.2 (3.2)	8	11.30
St. Ives	21.5	0.0	3	5.05 (3.4)	7	13.25
Hatfield Peverel	22.1	0.35	3	4.75 (2.5)	7	9.80
Cambridge	21.7	0.60	3	4.7 (2.4)	6	10.75
Mildenhall	21.6	0.0	2	4.05 (2.8)	5	10.70
Felixstowe	20.9	0.0	2	3.85 (2.4)	5	9.70

Mean = 0.62R - 8.8 inches

Formula for 5 areas

Mean = 0.81R - 13.1 inches

APPENDIX II

Mean excess winter rain with respect to Annual Rainfall and month when soil returns to capacity

Average Annual Rainfall	Month when capacity attained							
	June or July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
20-21.9	-	(6.10)	10.20	(6.25)	6.45	4.55	2.10	1.35	0.20
22-22.9	-	(9.30)	10.90	9.00	7.45	4.80	2.60	0.95	0.00
24-25.9	-	14.80	11.95	10.05	8.00	5.50	2.55	0.55	-
26-27.9	-	13.10	13.20	10.30	9.30	5.40	3.20	-	-
28-29.9	(18.10)	14.75	14.75	10.20	10.00	7.15	3.65	-	-
30-31.9	(18.20)	19.75	16.20	11.50	11.40	6.80	4.90	-	-
32-33.9	19.45	17.50	16.35	12.60	12.20	8.60	-	-	-
34-35.9	(15.90)	20.40	17.00	14.20	14.35	7.65	(6.30)	-	-
36-39.9	(32.90)	21.20	18.60	14.40	15.90	9.10	-	-	-

N.B. Figures in brackets indicate limited samples

Approximate formulae

Return in August	0.615R - 1.8
" in September	0.53R - 1.0
" in October	0.27R + 3.4
" in November	0.55R - 5.45
" in December	0.21R + 0.5
" in January	0.25R - 3.35

APPENDIX III

Mean excess winter rain with respect to soil moisture deficit at the end of August

Average Annual Rainfall	Capacity	0-1	1-2	2-3	3-4	4-5	5in(max)
20-21.9	(6.10)	8.25	9.10	6.40	3.55	3.95	4.05
22-23.9	8.60	8.80	8.75	5.70	6.00	5.40	4.00
24-25.9	12.70	11.35	9.80	8.35	6.80	5.65	5.40
26-27.9	12.40	11.50	11.90	9.20	7.45	6.60	8.25
28-29.9	15.20	13.50	12.15	10.00	9.00	7.75	13.70
30-31.9	19.45	15.55	11.80	11.90	9.90	9.55	12.10
32-33.9	18.00	15.50	15.20	12.35	11.10	10.60	17.00
34-35.9	20.20	17.65	16.35	14.45	13.80	11.30	16.05
36-39.9	21.85	19.70	15.45	14.75	14.90	14.95	(20.60)

Approximate formulae

Capacity	0.95R - 13.66
0-1 in	0.68R - 6.27
1-2 in	0.50R - 2.22
2-3 in	0.58R - 6.52
3-4 in	0.65R - 9.72
4-5 in	0.58R - 8.54
5in (max)	1.03R - 18.86